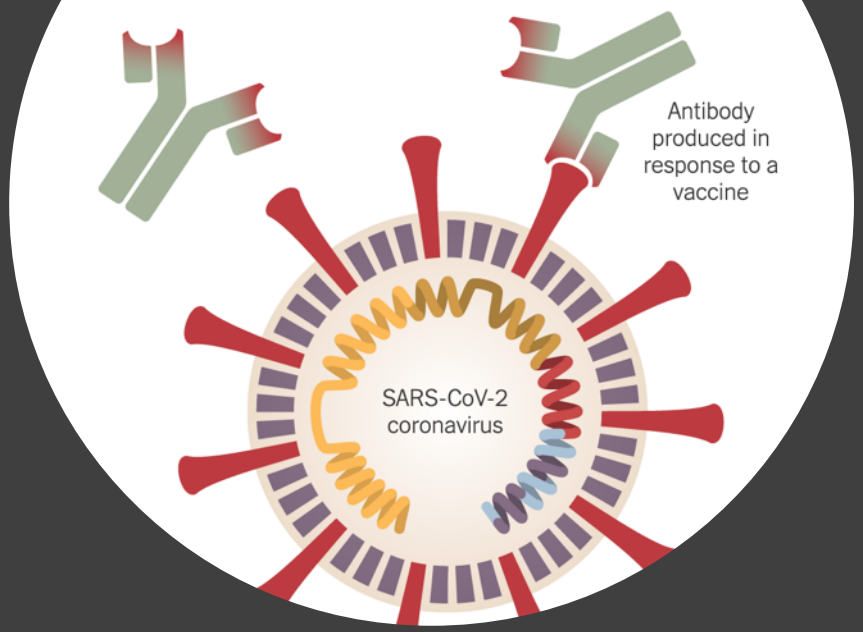
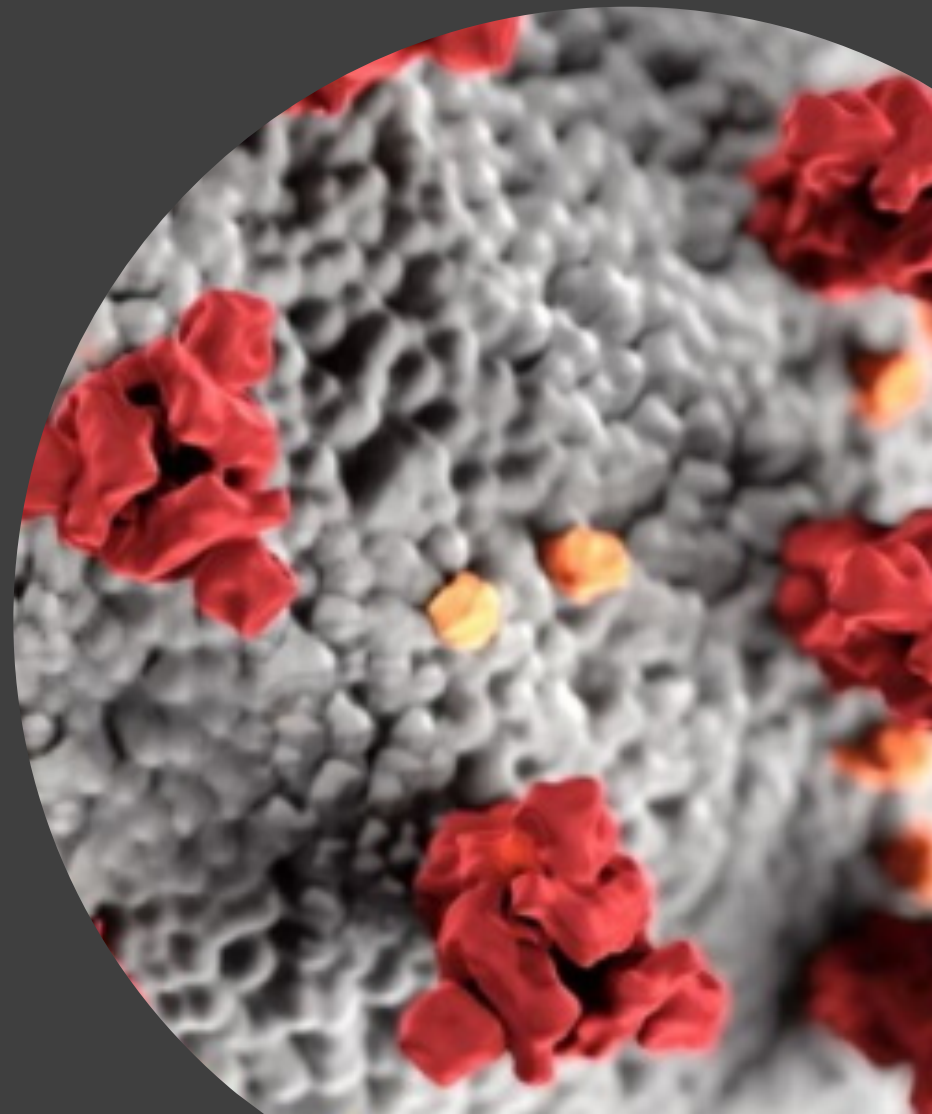


SARS CoV-2 Vaccines: commercial aviation considerations

Ian Hosegood
IAMA, Qantas



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Disclosure Information:

- I have no financial relationships to disclose.
- I will not discuss off-label use and/or investigational use in my presentation (only emergency vaccine use)
- I am employed by Qantas Airways Ltd
- I am presenting as a representative of the International Airline Medical Association (IAMA)
- Acknowledgements in creation of this deck:
  - IATA
  - McKinsey analyses
  - NYT and WP vaccine tracker graphics
  - IPSOS, WHO

Outline

- Vaccine Development:
  - Aims and value of the vaccine
  - Vaccine types and Current status
  - Performance: effectiveness, duration of immunity etc.
- Vaccine Roll-out:
  - Profile of production and distribution
  - Geographical coverage
  - Prioritisation by populations
  - Vaccine uptake
- Implementation in Aviation:
  - Impact on reopening of borders
  - Phases including a hybrid scenario with both testing and vaccines
  - Certification and recognition of vaccines
- The future
  - ‘Crystal ball’ - how will vaccines play out in aviation
  - What should governments / ICAO / Regulators do?

Four factors determining a vaccine's value to society

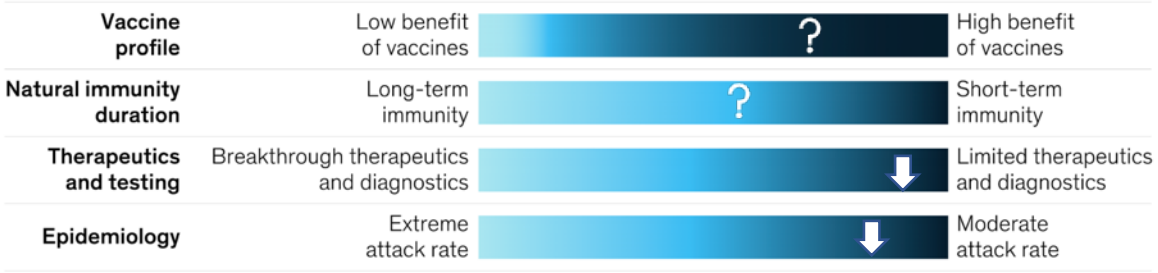
A vaccine may have a limited, focused, or outsize role in global recovery from the COVID-19 pandemic.

Vaccine impact by factor

Limited role Investments serve as important insurance policy for more extreme scenarios

Focused role Protecting vulnerable populations and saving lives in COVID-19 hot spots

Outsize role Saving lives as major countermeasure against COVID-19



Overall a SARS CoV-2 vaccine will almost certainly provide outsized role

		Lower value of vaccine	Higher value of vaccine
Vaccine profile		Unfavorable product profile: ● Low level of protection (eg, <50% efficacy) ● Limited duration of immunity (eg, <1 year) ● Distribution challenges (eg, short shelf life, complex cold chain) ● Inconvenient administration (eg, complex or novel devices, multiple doses)	Optimal product profile: ● High level of protection (eg, >70% efficacy) ● Extended duration of immunity (eg, >3 years) ● Simple logistics/distribution (eg, long shelf life, thermostable at room temperature) ● Convenient administration (eg, oral, single dose)
Vaccine context	**Natural immunity duration**	Long-term natural immunity: ● Extended duration (eg, lifetime) ● Slow virus mutation	Short-term natural immunity: ● Limited duration (eg, <12 months) ● Accelerated virus mutation
	Therapeutics and testing	Breakthrough therapeutics and diagnostics: ● Breakthrough therapeutics available at scale, especially for early stage and prevention ● Breakthrough testing available at scale	Limited therapeutics and diagnostics: ● Limited therapeutics available for COVID-19 treatment or prevention ● Marginal improvement of testing, with limited availability
	Epidemiology	Extreme attack rate: ● High R_0[1] (leading to herd immunity) or low R_0 (virus naturally waning down)	Moderate attack rate: ● Moderate R_0 (continuous infection without reaching herd immunity)

[1]Basic reproduction number.

Source: McKinsey: When will the COVID-19 pandemic end? November 23, 2020

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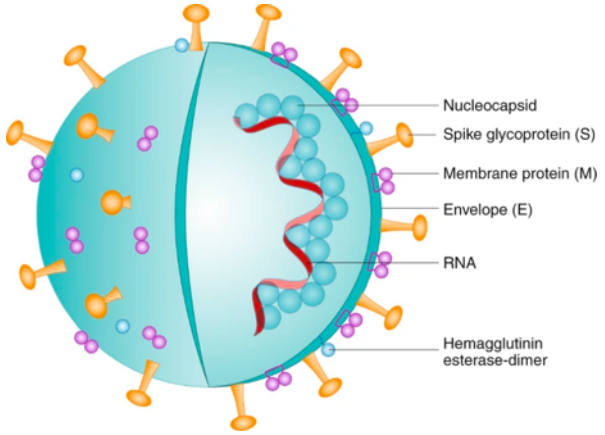
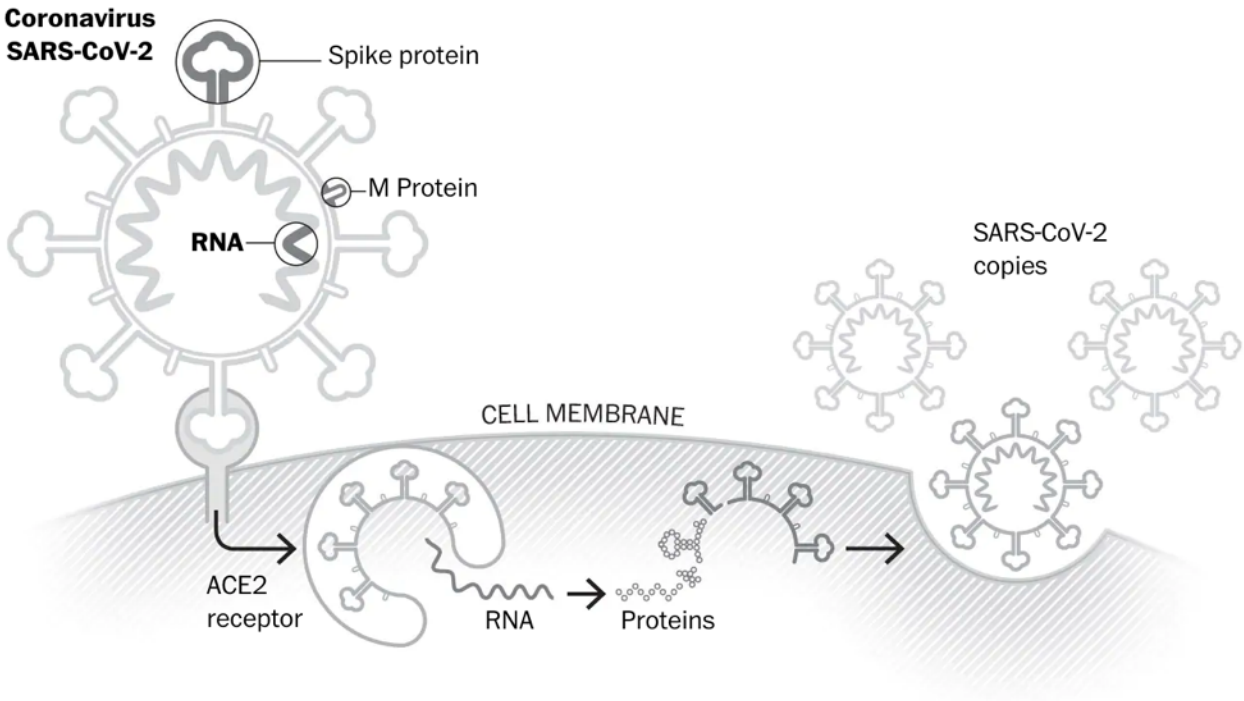
SARS CoV-2 replication process





SARS-CoV-2 uses its spike to bind to the ACE2 receptor, allowing access into the cell.

The virus's RNA is released into the cell. The cell reads the RNA and makes proteins.

The viral proteins are then assembled into new copies of the virus.

The copies are released and go on to infect more cells.

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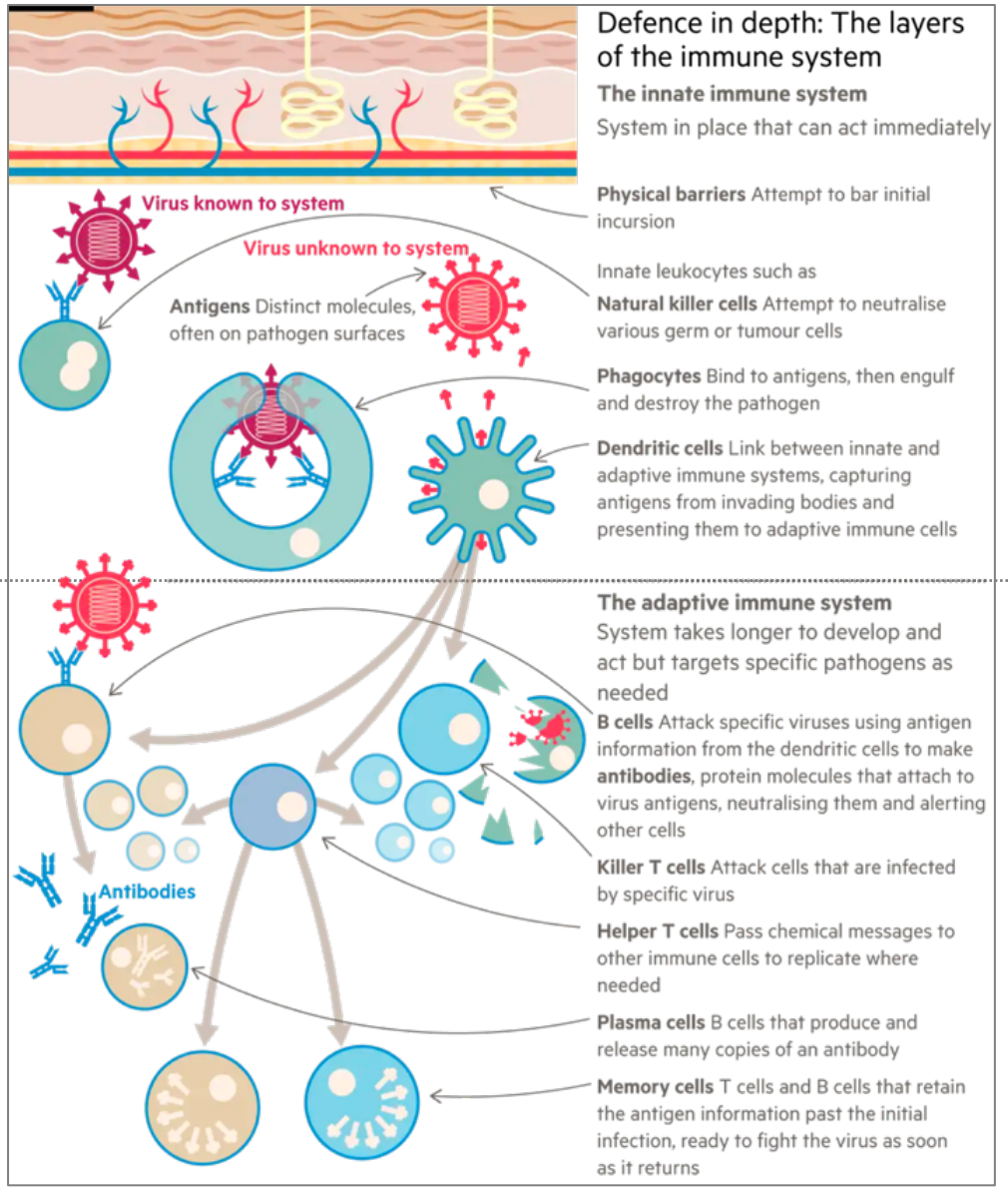
Immune system: innate and adaptive systems



Source: FT Research (copyright Financial Times)

Innate Immune System:

- The first line of defence
- non-specific / independent of antigen
- consists of physical, chemical and cellular defences
- Immediate response (0-4 days) to prevent the spread and movement of pathogens
- Physical – skin, hair, cough, mucous membranes
- Phagocytes, granulocytes
- Cellular - Natural killer cells, macrophages, neutrophils, dendritic cells, mast cells, basophils, eosinophils

Adaptive Immunity:

- Acquired / specific immunity (antigen dependent)
- Longer term (< 4days)
- Has humoral and cellular components

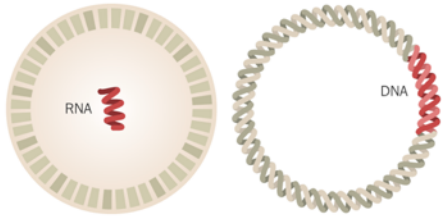
- Cellular
- hallmark is clonal expansion of (T and B) lymphocytes from one or a few cells to millions..
- Cellular immunity occurs inside infected cells
- mediated by T lymphocytes.

- Humoral
- With assistance from helper T cells, B cells differentiate into plasma B cells that produce antibodies.
- long-lasting, highly specific, and is sustained long-term by memory T cells.

Vaccine types

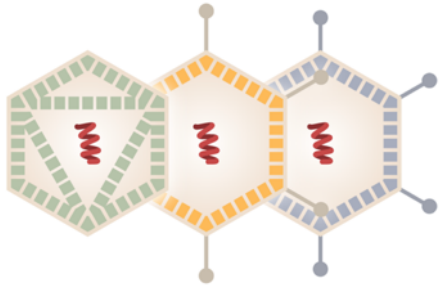
Genetic Vaccines

Vaccines that use one or more of the coronavirus's own genes to provoke an immune response.



Viral Vector Vaccines

Vaccines that use a virus to deliver coronavirus genes into cells. The cells make viral proteins, provoking an immune response, but the virus cannot replicate.



Whole-Virus Vaccines

Vaccines that use a weakened or inactivated version of the coronavirus to provoke an immune response.

Protein-Based Vaccines

Vaccines that use a coronavirus protein or a protein fragment to provoke an immune response.

Technology used: Nucleic acid · Viral-vectored · Subunit · Virus · Other

Repurposed Vaccines

Vaccines already in use for other diseases that may also protect against Covid-19.

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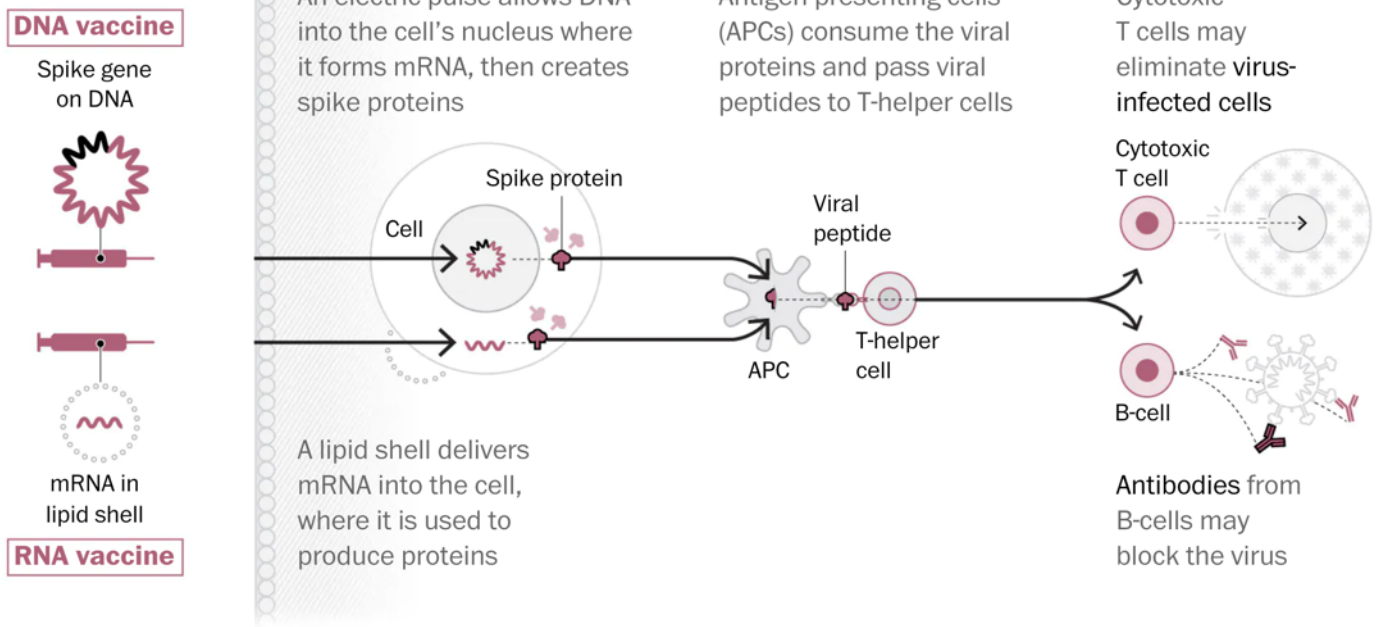
Vaccine types: genetic / nucleic acid vaccines



Nucleic acid vaccines, developed by...

	PC	P1	P2	P3	A
Moderna; National Institutes of Health	■	■	■	■	■
Pfizer; BioNTech; Fosun Pharma	■	■	■	■	■
CureVac	■	■	■	■	
AnGes; Osaka University; Takara Bio	■	■	■		

*Vaccine currently in distribution that has not been fully tested.

At least 20 teams are using DNA or RNA.
Nucleic acid is inserted into human cells, which then churn out copies of the virus protein; most of these vaccines encode the virus's spike protein.

mRNA Vaccines

- Newest generation
- All components are produced synthetically
- Antigen expression
- Used in development of immunotherapies

Advantages

- No live materials (safe) & QC is better
- Quick production/manufacturing switch
- Incorporated into lipid nanoparticle for transfection
- Pfizer/Moderna vaccine – encode S protein

- Disadvantage:
  - Very new – no prior human vaccines
  - Ultra-cold chain

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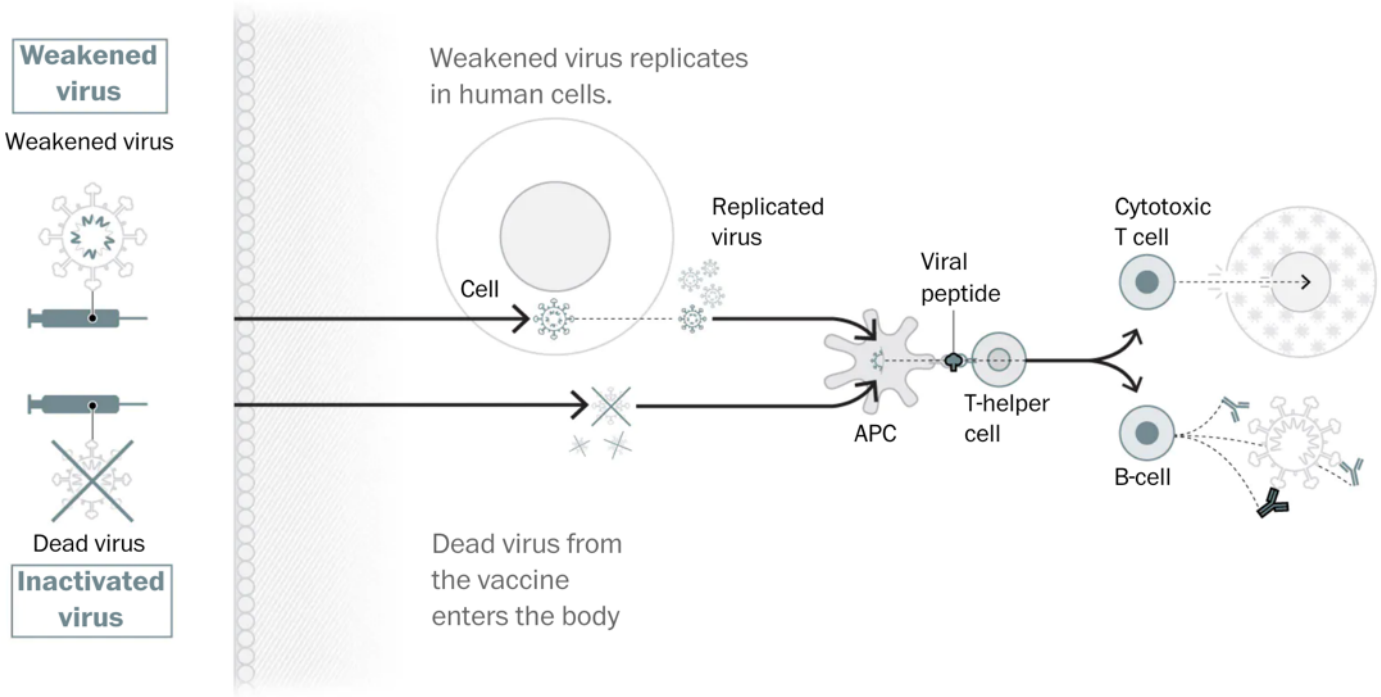
Types of vaccines: Weakened or inactivated virus vaccines



Weakened and inactivated virus vaccines, developed by...

	PC	P1	P2	P3	A
Beijing Institute of Biological Products; Sinopharm					
Bharat Biotech					
Research Institute for Biological Safety Problems, Republic of Kazakhstan					
Sinopharm					

*Vaccine currently in distribution that has not been fully tested.

- Live-attenuated
  - Live pathogen with attenuated virulence
  - Mild infection resembling the real infection
  - Strong immune response and immune memory
- Disadvantages
  - Safety –cause real infection (immunocompromised) and can revert to virulent strain
  - Manufacturing requires handling live virus
- Inactivated
  - Safer than live-attenuated but not as immunogenic so multiple doses need to be given to establish immune memory
  - Manufacturing defects can lead to disease outbreaks (Cutter Incident)

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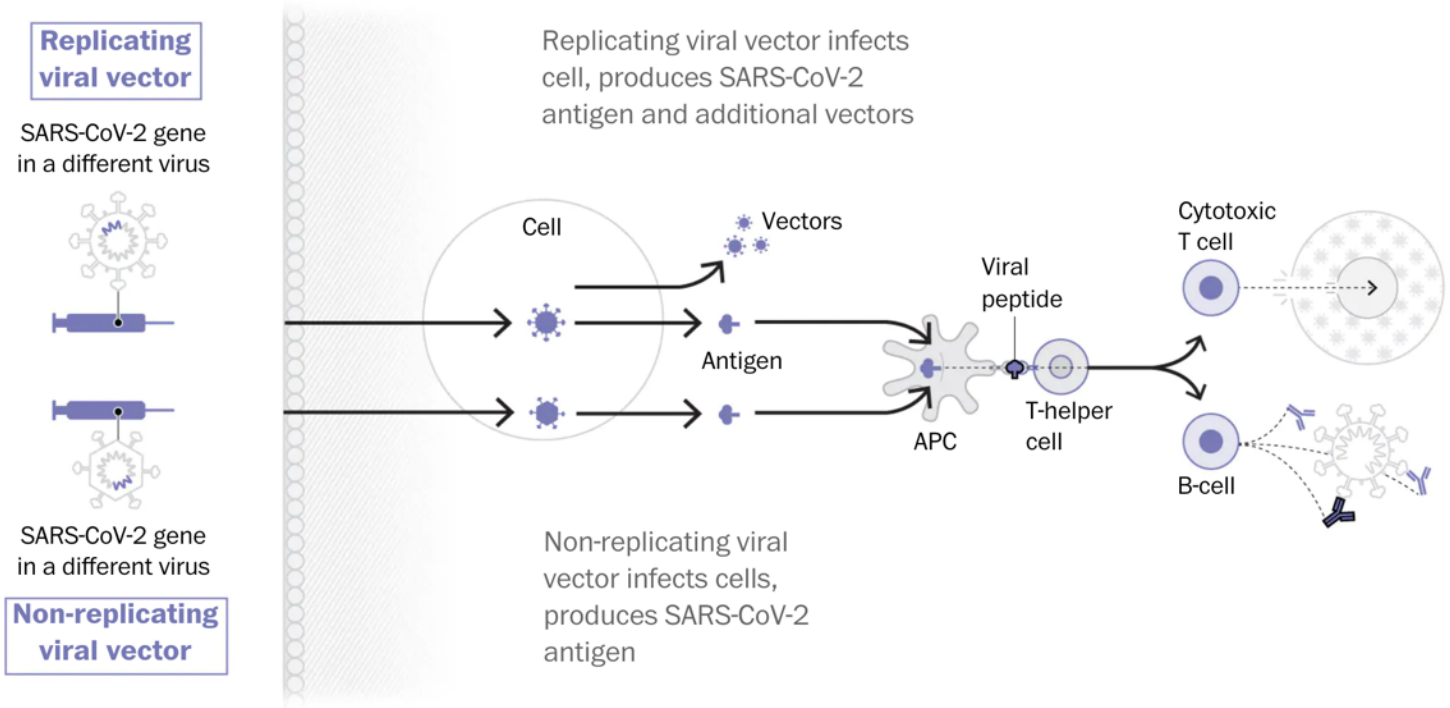
Vaccine types: vector based



Viral-vectored vaccines, developed by...

	PC	P1	P2	P3	A
AstraZeneca; University of Oxford					
CanSino Biologics; Beijing Institute of Biotechnology*					
Gamaleya Research Institute*					
Johnson & Johnson, Beth Israel Deaconess Medical Center					

*Vaccine currently in distribution that has not been fully tested.

Images: copyright Washington Post

Viral-vector vaccines

- Around 25 groups are working on viral-vector vaccines.
- A virus (measles or adenovirus) is genetically engineered so that it can produce coronavirus proteins in the body (by cloning the antigen).
- Weakened so they cannot cause disease.
- There are two types: those that can still replicate within cells and those that cannot because key genes have been disabled.
- Elicits a T cell response (memory)
- Disadvantage: Scaling up (grown in cell lines) is an issue ⍰ yield, impurity clearance (including host DNA), quality and cost
- Can also use Bacteria - Non pathogenic lactic acid bacteria (LAB) -COVID 19 vaccine candidate of Symvivo
- Safe (LAB used as a food additive), manufacturing costs are low and can be lyophilised (freeze dried)) for better stability

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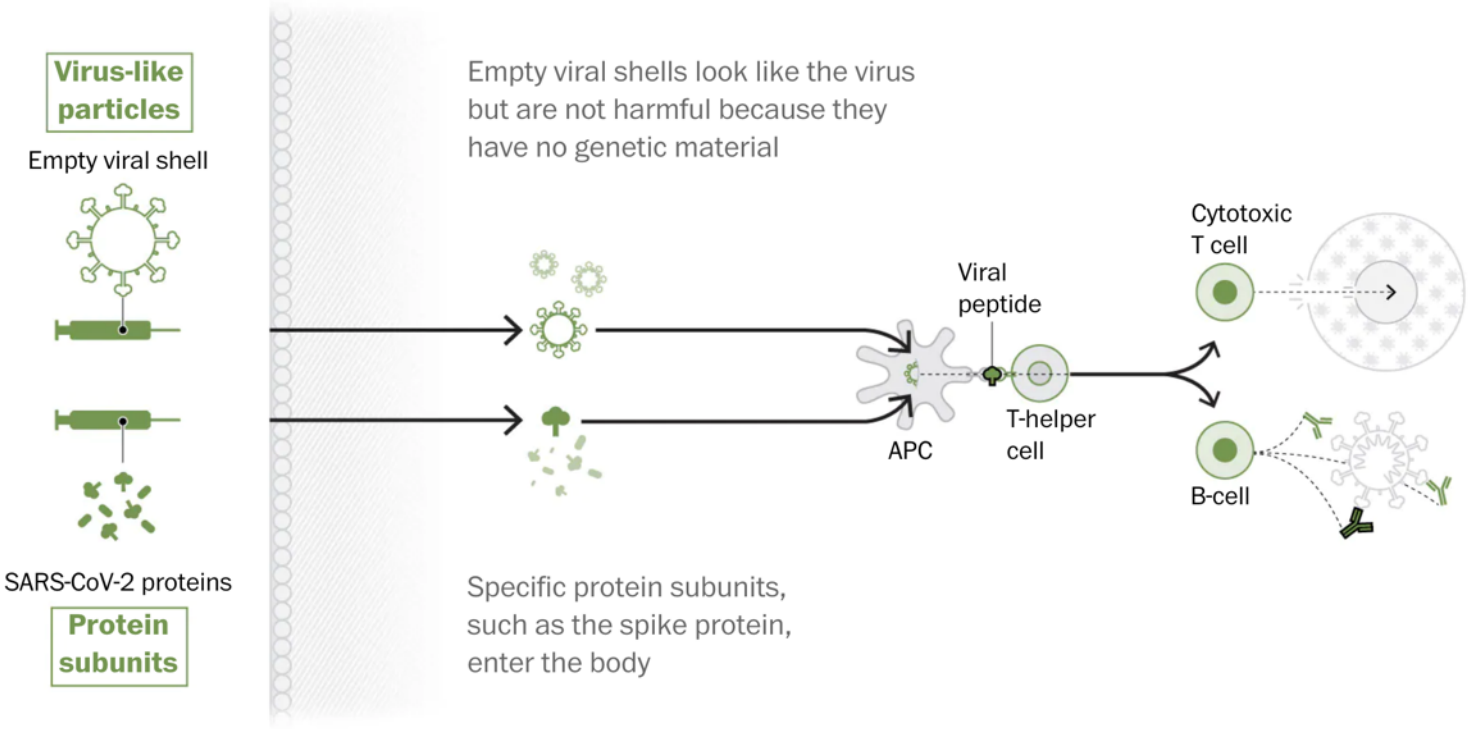
Vaccine types: Subunit / Protein based



- Involves injecting coronavirus protein subunits directly into the body.
- Fragments of proteins or protein shells that mimic the coronavirus's outer coat (VLP) can also be used.
- Difficult to manufacture

Subunit vaccines, developed by...

Anhui Zhifei Longcom; Chinese Academy of Sciences	PC P1 P2 P3 A
Novavax	PC P1 P2 P3 A
Federal Budgetary Research Institution (FBRI) State Research Center of Virology and Biotechnology "VECTOR"	PC P1 P2 P3 A
Instituto Finlay de Vacunas	PC P1 P2 P3 A

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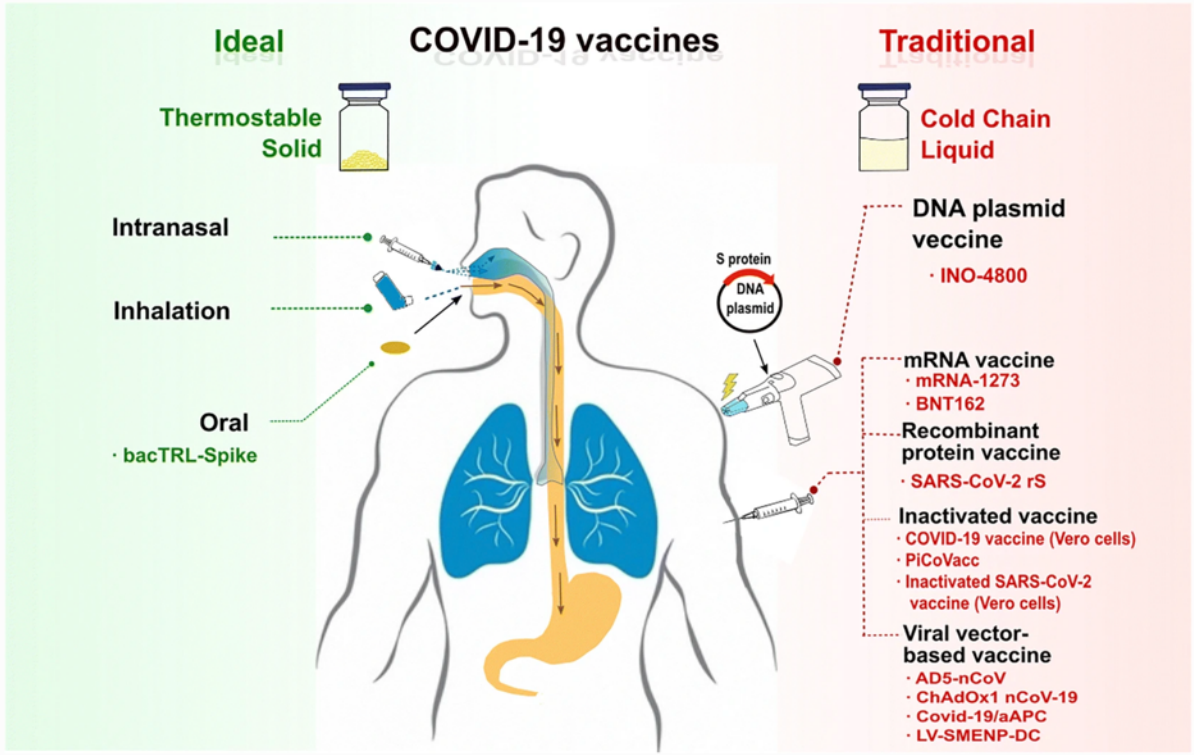
Ideal vs traditional vaccine: stability and route of administration

- Ideally -Ready-to-use that can be stored at ambient temperature and long shelf-life
  - Reality is cold chain (or ultra-cold) dependence
- Ideally inhaled oral or intranasal (Bacterial vector one)
  - Reality is majority will be injectable.
- Can affect the extent and quality the immune response
- COVID 19 is a respiratory disease so developing mucosal immunity is ideal
- Thus, an intranasal, pulmonary or oral route of administration might be superior but:
  - FDA has mostly only approved parenterally administered vaccines (systemic immunity only)
  - There are 3 intranasal influenza vaccines available
  - Inactivated or subunit so difficult to commercialize



A comparison of routes of administration between the ideal vaccines and the current COVID-19 vaccine candidates

Wang, J., Peng, Y., Xu, H. *et al.* The COVID-19 Vaccine Race: Challenges and Opportunities in Vaccine Formulation. *AAPS PharmSciTech* **21,** 225 (2020). https://doi.org/10.1208/s12249-020-01744-7

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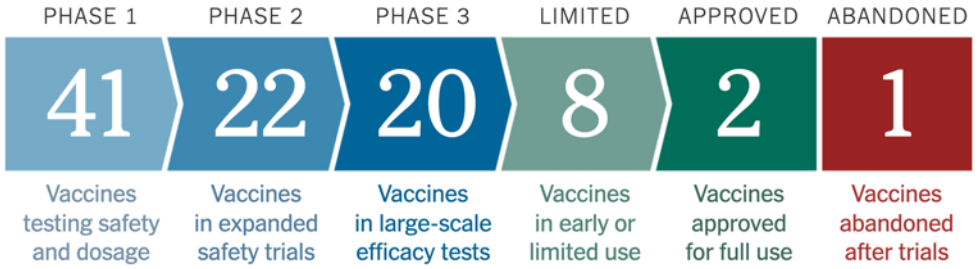
Vaccine Development: current status

Landscape of candidate vaccines:

- 2 full approvals, 8 EUA
- 83 candidate vaccines in clinical trials
- 5 candidates have announced interim Phase III efficacy results so far:
  - **Pfizer/BioNtech:** 95%
  - **Moderna:** 94%
  - **Astra Zeneca:** 62-90% (70%)
  - **Sinopharm*** 79%
  - **Sputnik*** 91.4%
- Many questions remain unanswered:
  - Impact on transmission vs disease prevention
  - Impact on reducing severe cases of COVID-19
  - Effectiveness in different sub-populations (e.g. elderly, pregnant, kids)
  - Long-term data on safety
  - Optimal dosing (and timing intervals)
  - Duration of immunity – need for regular re-vaccination?

* Results not published / shared publicly

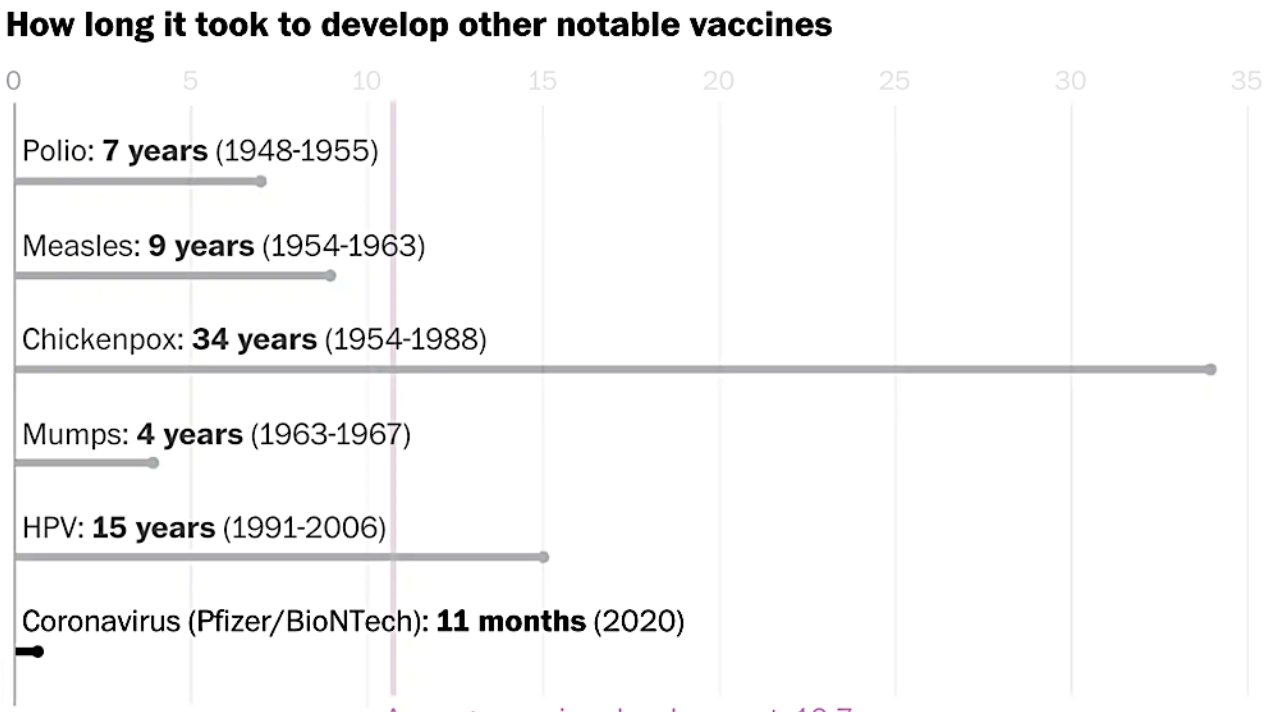


Leading vaccines

Developer	How It Works	Phase	Status
Pfizer-BioNTech	mRNA	2 3	Approved in Saudi Arabia and other countries. Emergency use in U.S., E.U., other countries.
Moderna	mRNA	3	Emergency use in U.S., E.U., other countries.
Gamaleya	Ad26, Ad5	3	Early use in Russia. Emergency use in Belarus, other countries.
Oxford-AstraZeneca	ChAdOx1	2 3	Emergency use in Britain, India, other countries.
CanSino	Ad5	3	Limited use in China.
Johnson & Johnson	Ad26	3	
Vector Institute	Protein	3	Early use in Russia.
Novavax	Protein	3	
Sinopharm	Inactivated	3	Approved in China, U.A.E., Bahrain. Emergency use in Egypt.
Sinovac	Inactivated	3	Limited use in China.
Sinopharm-Wuhan	Inactivated	3	Limited use in China, U.A.E.
Bharat Biotech	Inactivated	3	Emergency use in India.

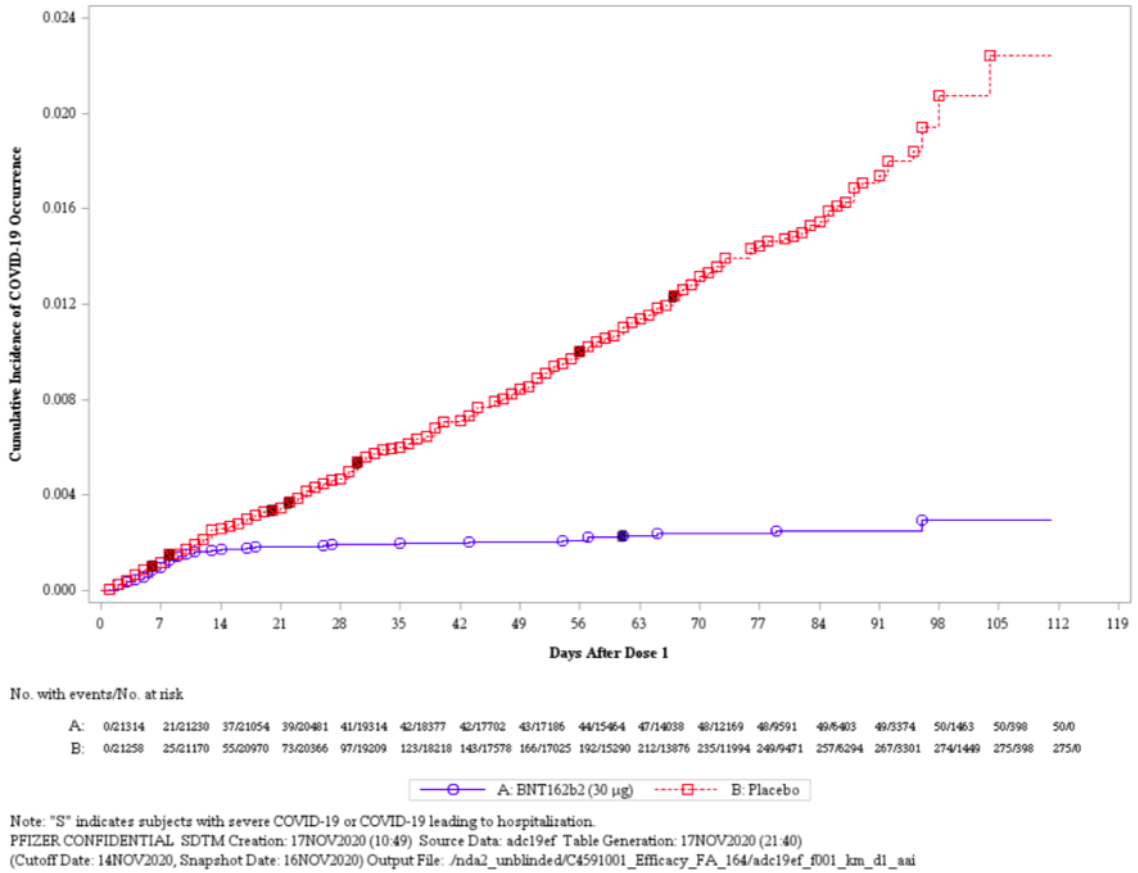
Sources: World Health Organization, Images: copyright New York Times

mRNA Vaccines: a miracle of modern medicine?



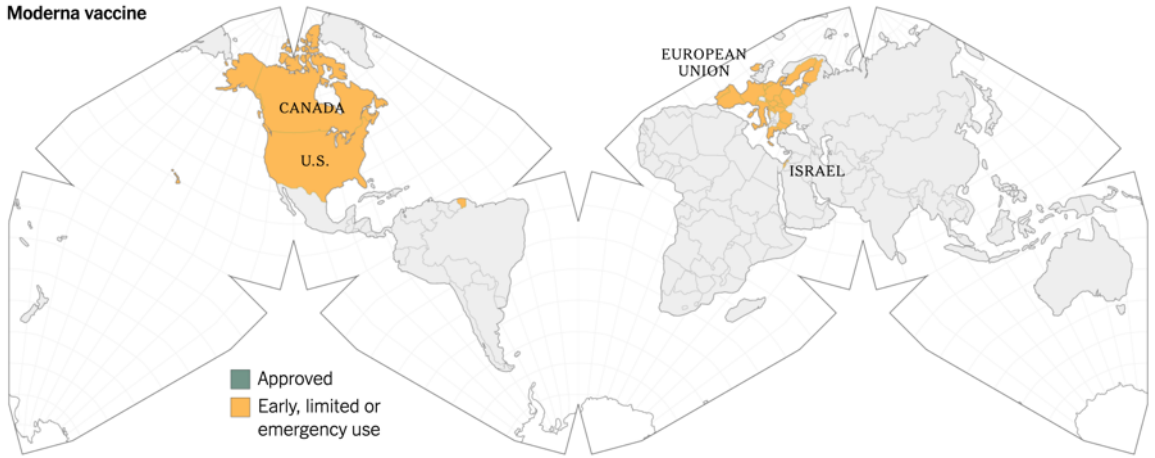
Average vaccine development: 10.7 years

Image: copyright Washington Post

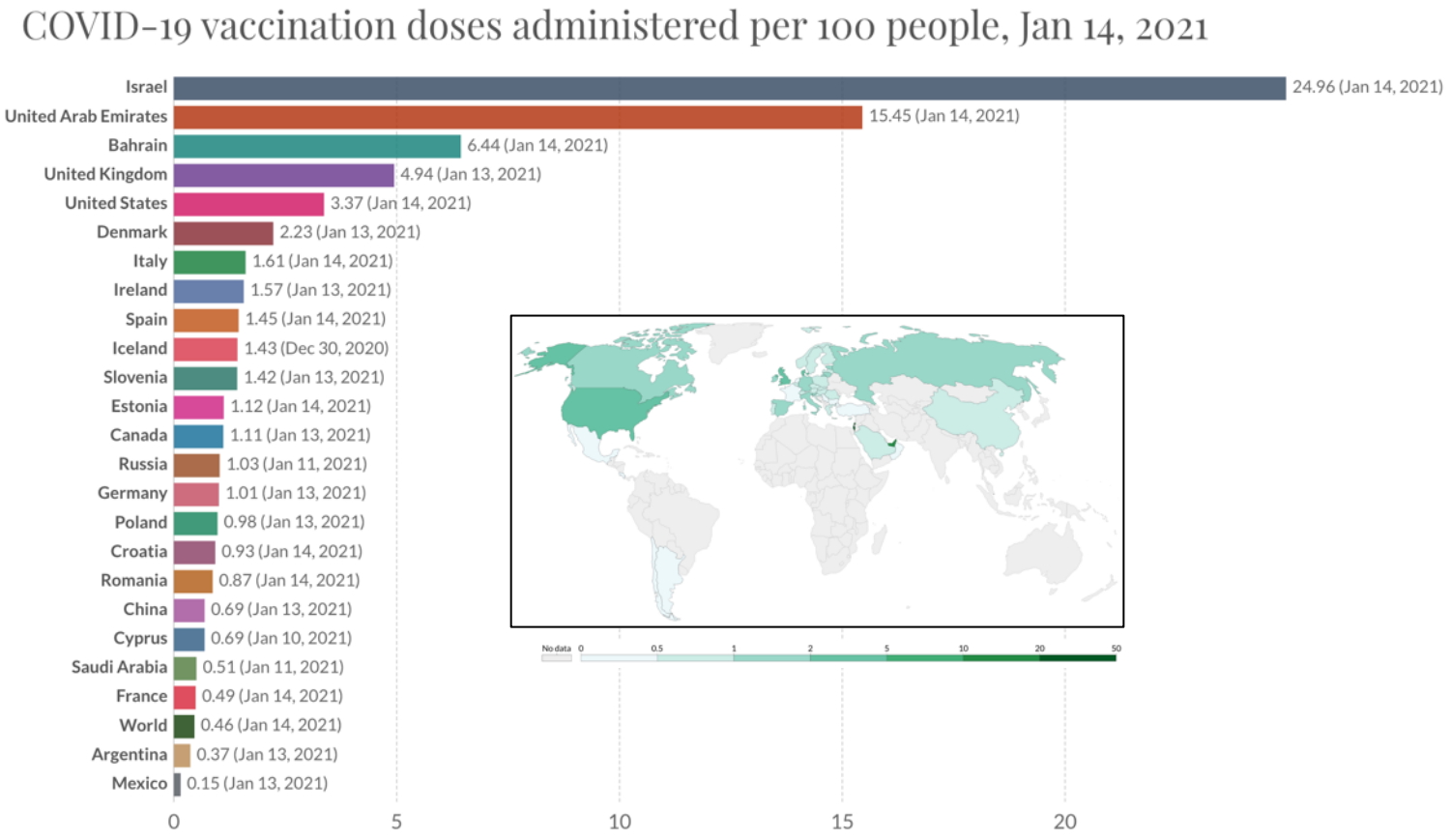


Polack FP, Thomas SJ, Kitchin N, et al. Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine. *N Engl J Med*. 2020;383(27):2603-2615. doi:10.1056/NEJMoa2034577

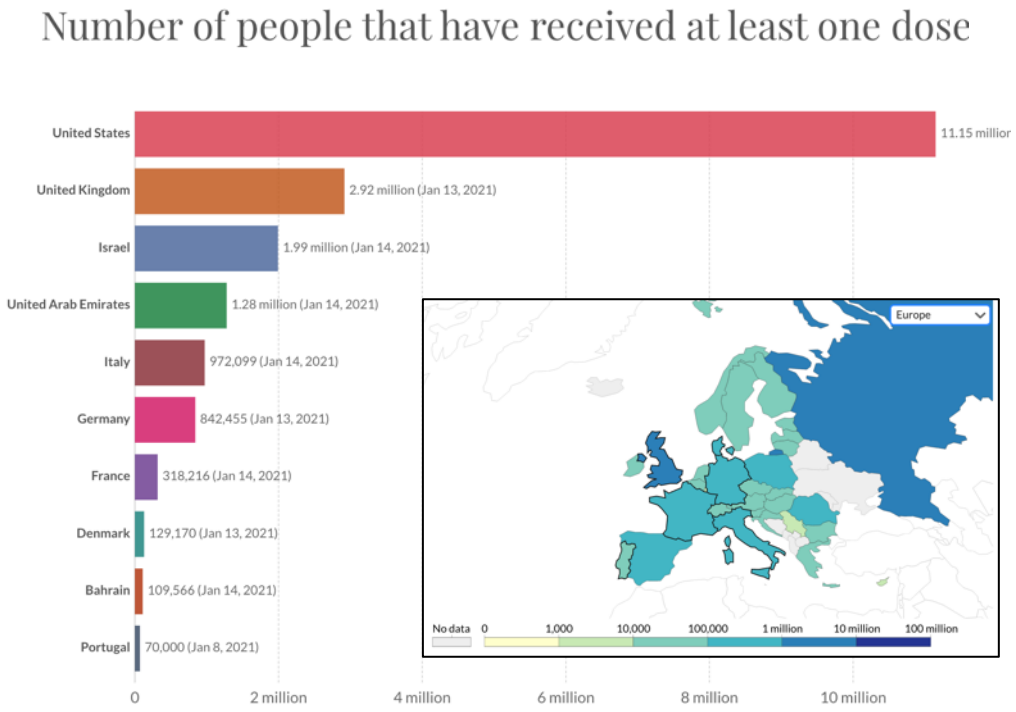
Worldwide Vaccine Approval Status



Covid-19 vaccine doses administered as at 14 Jan 2021



Total doses administered per 100 people (may not be fully vaccinated for two dose regimen)



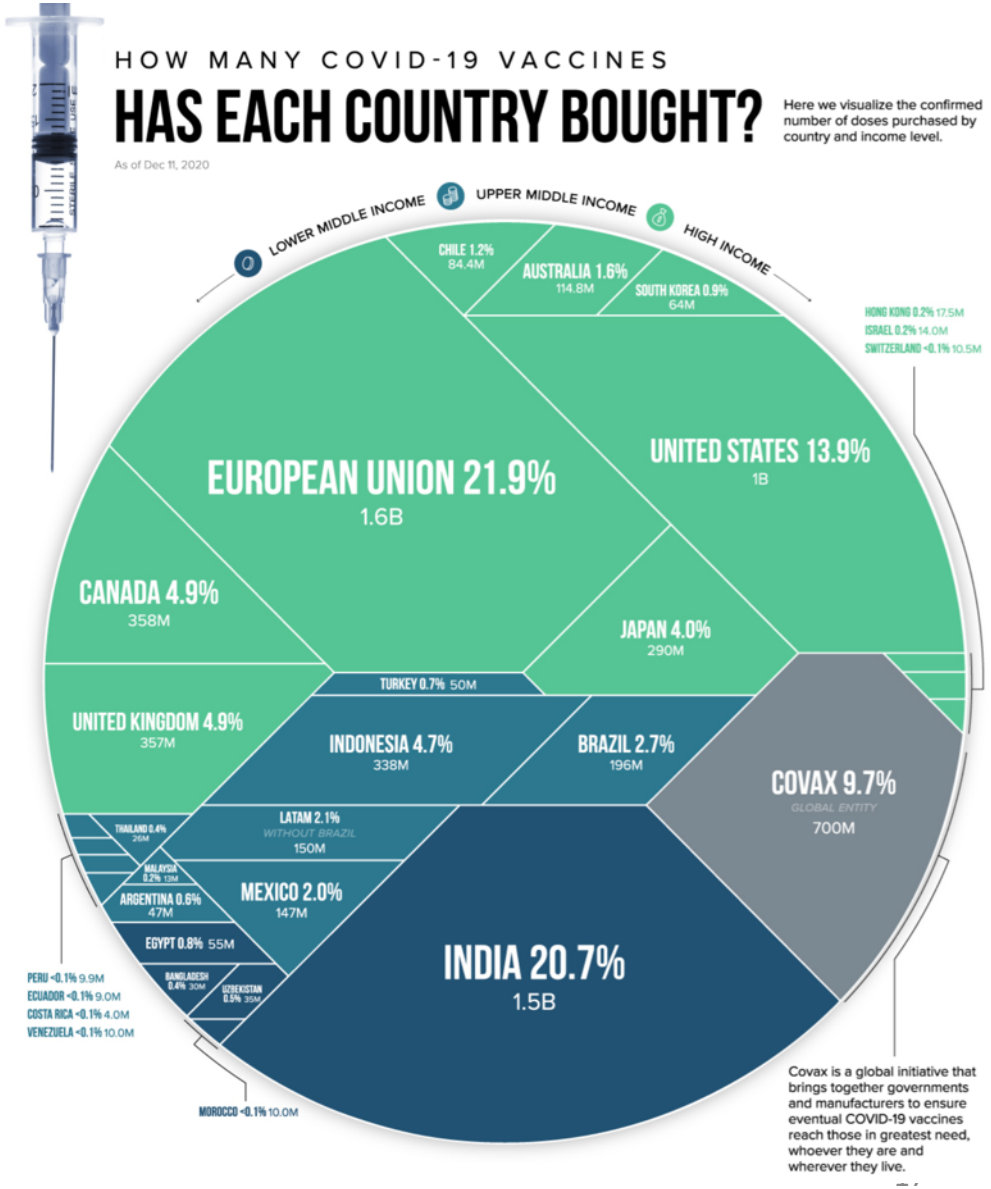
Total number of people who have received at least one vaccine dose (may not be fully vaccinated for two dose regimen)

Images: ourworldindata.org accessed 14 Jan 2021

Vaccine purchase: Geographic Coverage

- **Geographic coverage of access to vaccines uneven**
- Many countries have signed Advanced Market Commitments (AMCs) to secure access to candidate vaccines
- More than 50% of these pre-purchased doses accounted for by high-income countries:
  - US Project ‘Warp Speed’: 1 billion doses, 6 manufacturers
  - Canada: 10 doses per person
- 600m doses of Pfizer/BioNtech vaccine already purchased
  - 50% of production to end-2021
- Distribution of Pfizer/BioNtech vaccine will be a major challenge – particularly in lower-income countries.
- AstraZeneca/Oxford much easier to distribute

Major air travel markets are likely to secure early access to limited vaccine doses



Source: https://www.visualcapitalist.com/tracking-covid-19-vaccines-around-the-world/

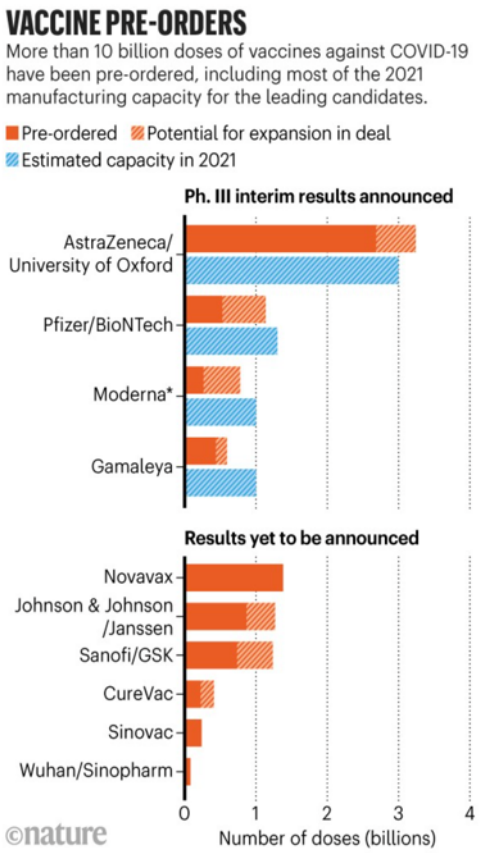
Vaccine Roll-out: production

Global vaccine roll-out likely to take at least 1-2 years

- Astra Zeneca / Oxford, Pfizer/BioNtech and Moderna could deliver 4 billion vaccine doses by end 2021:
- Sufficient to vaccinate 2 billion people.

- If all candidate vaccines in Phase 3 trials are successful, anticipated production capacity would be 8.4 billion doses by end 2021:
- Sufficient to vaccinate 50%+ of global population

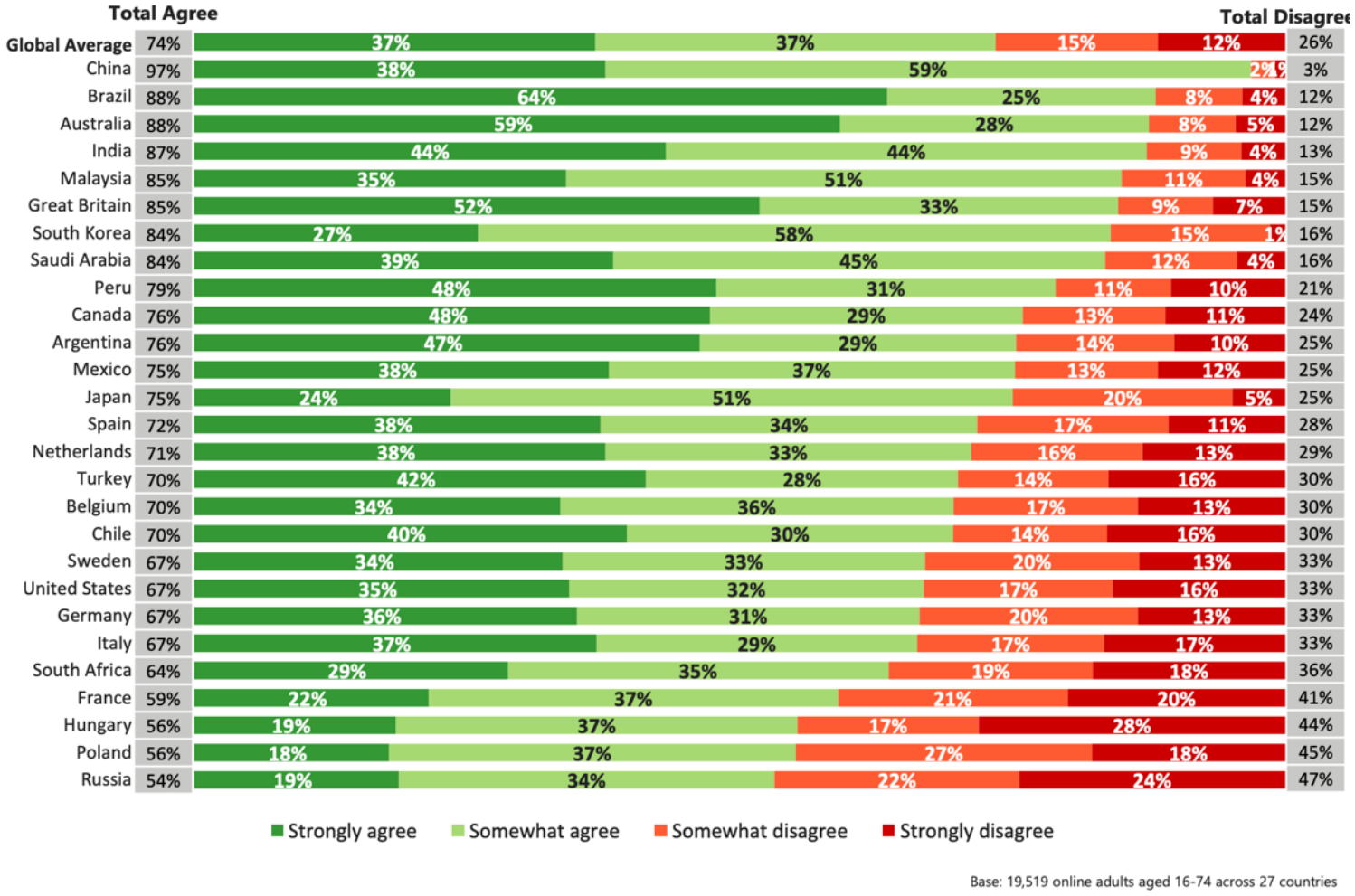
- Does not take into account any need for ongoing / regular revaccinations



Sources: McKinsey, Nature

If a COVID vaccine were available, I would get it

- Globally, 74% agree that they would get a COVID-19 vaccine should it become available, while 26% disagree.
- China is a stand-out, where virtually all agree. On the other hand, online adults in Hungary, Poland, and Russia prove more divided.
- In most countries, those who agree outnumber those who disagree by a significant margin (exceeding 50 points in 12 out of 27 countries).

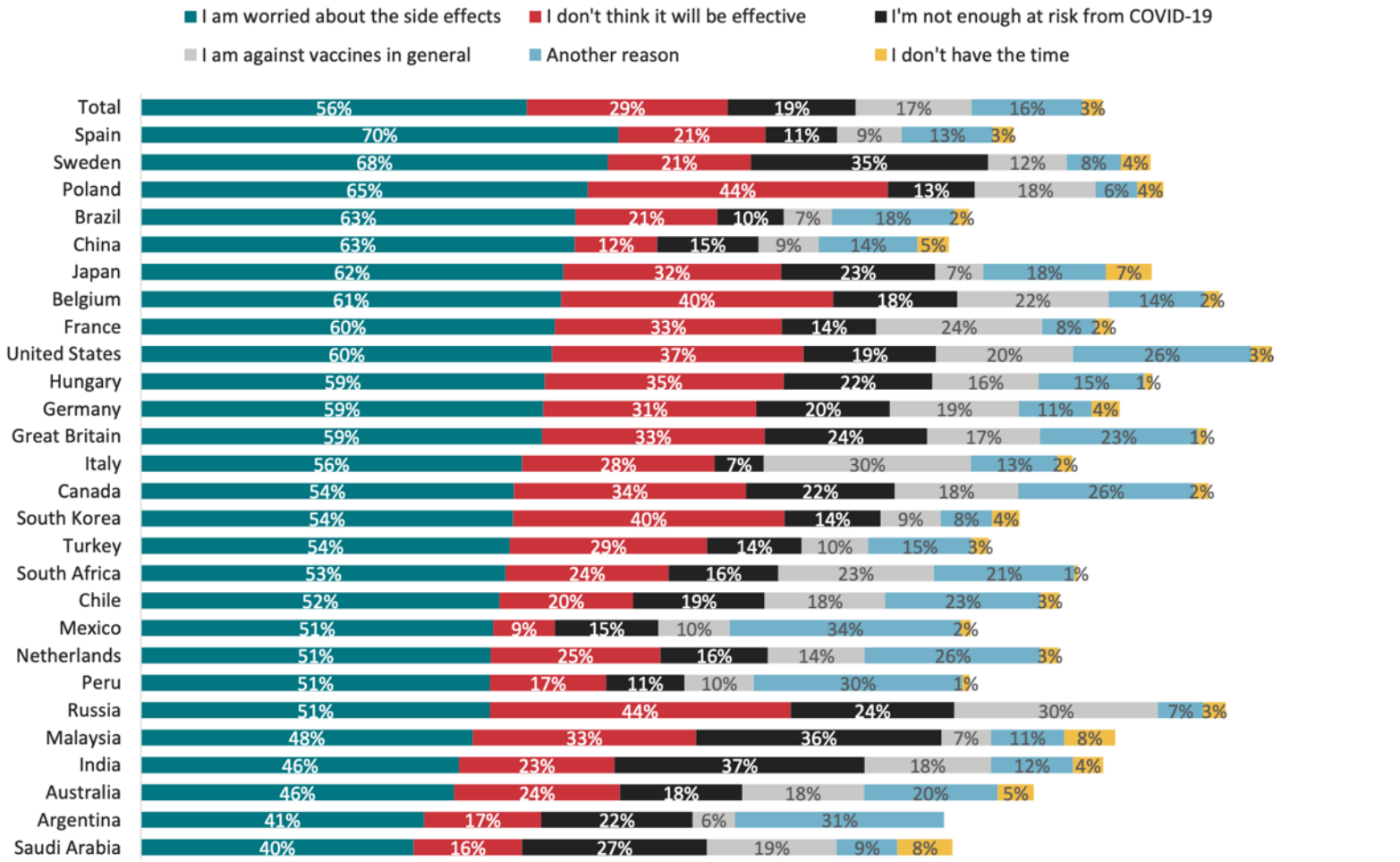


Base: 19,519 online adults aged 16-74 across 27 countries

Ipsos survey for the World Economic Forum Conducted on Global Advisor (July 24 - August 7, 2020)

Uptake: Reasons for not taking a vaccine

- The most frequently mentioned reason for not taking a vaccine among those who would not get one is worry about side effects
- Next is perception of effectiveness.
- Several countries where as many as one third feel they are not sufficiently at risk.
- Anti-vax sentiment is 17% on average



Percentages add up to more than 100% as multiple answers were allowed

Base: 4,860 online adults aged 16-74 across 27 countries

Ipsos survey for the World Economic Forum Conducted on Global Advisor (July 24 - August 7, 2020)

Vaccine Roll-out: Prioritization / Allocation

- Where vaccine supply is limited, governments will need to allocate scarce vaccine doses
- Criteria will be a decision for governments, but WHO has recommended a priority ordering in which healthcare workers, older adults and vulnerable groups will be prioritised
- Transportation workers would have access to vaccination in Stage 3, once 20%+ of the population has been vaccinated. Reflects recognition of the importance of air transport in distribution of vaccines
- WHO does not recommend prioritizing travelers. Access to vaccination for travel would only be possible once vaccines are widely available
- Priorities may alter in different scenarios:
  - Widespread community transmission – focus on health care workers and vulnerable
  - Localised clusters or sporadic outbreaks – as above but focus on regions of risk and hold reserves to respond
  - No cases scenario – border and transportation workers become a higher priority as a potential source of incursion

WHO Recommendation for Priority Use if supply is limited

Supply Level	**WHO Recommended Prioritization** (Community transmission scenario)
Stage 1: Very limited (0-10% of population)	• Health workers at high risk • Older adults
Stage 2: Limited (11-20% of population)	• Older adults (not covered in Stage 1) • High risk groups (comorbidities, vulnerable) • Health workers involved in vaccine delivery • Teachers and school staff
Stage 3: Moderate (21-50% of population)	• **Essential workers (including transportation)** • Pregnant women • Health workers at low / moderate risk • Social / employment groups at elevated risk

Source: *WHO SAGE ROADMAP FOR PRIORITIZING USES OF COVID 19 VACCINES IN THE CONTEXT OF LIMITED SUPPLY An approach to inform planning and subsequent recommendations based upon epidemiologic setting and vaccine supply scenarios. November 2020. Version 1.1*

Possible aviation phases in vaccine Roll-out scenario

1

Phase 1: Very limited vaccinations (<10% of population)

- Testing as the primary cross-border risk mitigation measure
- Nations still experiencing widespread community transmission and differing prevalence
- Airlines and governments not yet ready to manage vaccine complexities
- But any traveler who has been vaccinated should be free from quarantine and testing

2

Phase 2: Vulnerable groups vaccinated (~25% of population)

- Level of COVID infection still high, but impact (risk of serious illness or death) significantly reduced
- Border measures and quarantine should be relaxed immediately. Testing need no longer be mandatory
- Airlines may choose to retain testing as a passenger confidence measure
- Mandatory vaccination requirement would be a brake on restart / recovery if limited access

3

Phase 3: Vaccination widely available

- States may impose vaccination / antibody testing requirements.
- But, legal / ethical issues to address
- Testing may provide alternate pathway for those unable to be vaccinated
- Health care system not overwhelmed and no significant excess deaths

4

Phase 4: Steady State

Either:

- herd immunity attained – virus transmission massively reduced

Or:

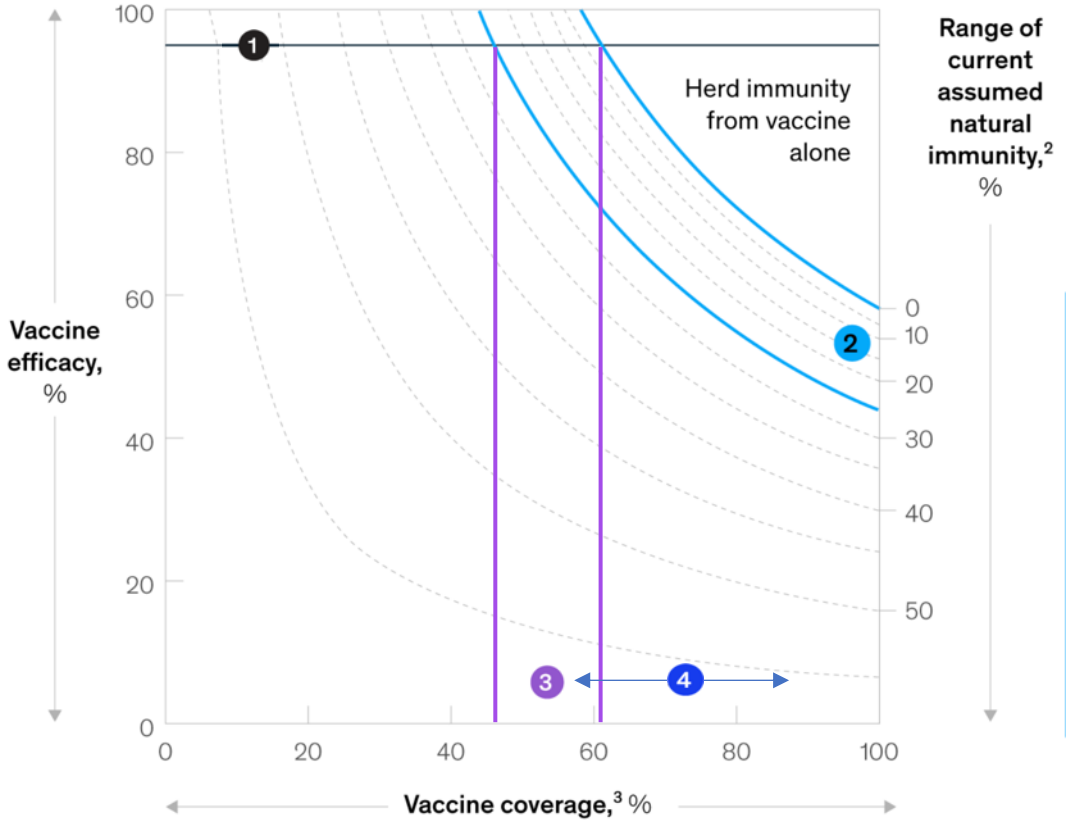
- virus mutates / immunity short-lived – regular re-vaccination required

COVID-19 should be managed as for influenza

-Pace of roll-out will vary widely between countries and nations will have differing risk perceptions of both outbound (citizens leaving and returning) and inbound (foreign visitors) international travel.

-Testing and vaccines will co-exist

Immunity scenarios and functional pandemic end based on vaccine scenarios



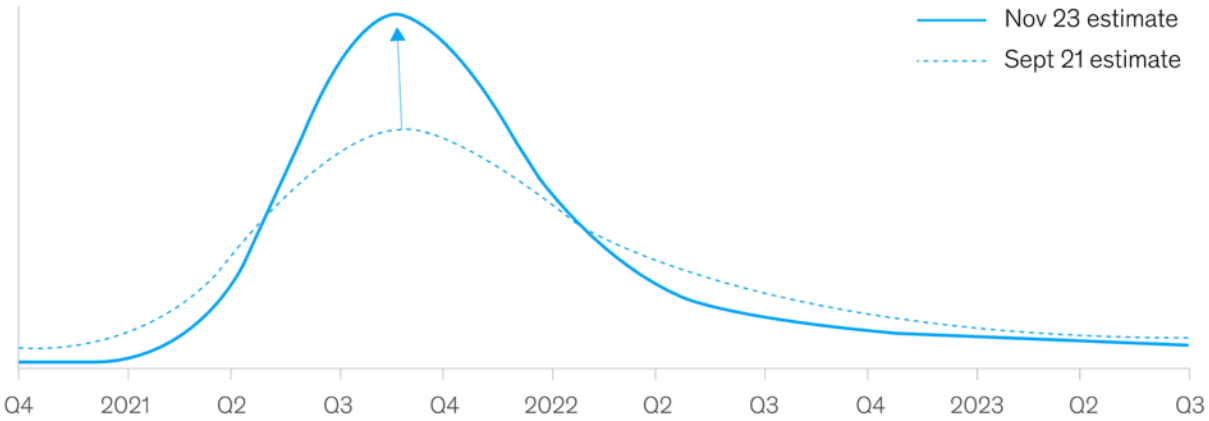
1
Two new vaccines have shown efficacy of **~95 percent**

2
US seroprevalence (natural immunity) is widely believed to be between **0–25%**[2]

3
The intersection of these values for efficacy and seroprevalence suggests that required coverage for the US is **~45–65%**

4
The model assumes that vaccines are distributed to adults and children. The new vaccines may not be indicated for children. If only adults are vaccinated, coverage may need to be 30% higher (ie, **58–85%** vaccine coverage)

Probability of functional end[1] to COVID-19 pandemic in US[2] by quarter (illustrative) McKinsey



Early herd immunity if:

- Vaccine rollout and adoption is faster than expected
- Natural immunity is significantly higher than realized

Peak probability of herd immunity (Q3/Q4 2021) driven by:

- Emergency use authorization (EUA) of 1+ candidates in Dec 2020/Jan 2021
- Biologic license application (BLA) (with full approval by March/April 2021)
- Approximately 6 months for manufacturing, distribution and sufficient adoption to reach herd immunity

Later herd immunity if one or more of the following occur:

- Safety issues delay EUA and/or BLA
- Manufacturing/supply chain issues slow rollout
- Adoption is slower than anticipated
- Duration of immunity is short
- Vaccine prevents disease progression but does not meaningfully reduce transmission

[1]A functional end to the epidemic is defined as reaching a point where significant, ongoing public health measures are not needed to prohibit future spikes in disease and mortality (this might be achieved while there are still a number of people in particular communities who still have the disease, as is the case with measles).
[2]Timeline to functional end is likely to vary somewhat based on geography.
Source: Information compiled from a variety of public statements and sources (ie, *Atlantic*; CDC; Cell [June 2020]; FDA; MedRxiv; *Nature; Nature Reviews* [August 2020, July 2020]; *NY Magazine; Oxford Academic; PNAS; Science; Science Advances; Science Immunology* [June 2020]; WHO); interviews with relevant experts; and surveys conducted by McKinsey and others

Source: McKinsey: When will the COVID-19 pandemic end? November 23, 2020

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Key drivers of Vaccine adoption: the hurdle race

Available	Administrable	Accessible	Acceptable	Affordable	Accountable
Vaccine is approved and in sufficient supply to reach the population.	*Appropriate individuals can receive vaccination at convenient locations.*	*Vaccine is distributed and stored for use.*	*Consumers have accurate information they trust, and they choose to be vaccinated.*	*Costs of vaccine and administration are amenable to both payers (public/ government and private) and consumers.*	*Patients receive full course of treatment, and monitoring is in place on post-launch outcomes.*
Technology portfolio and access	Population segmentation	Ordering	Public communica-tions, messaging, and education	Funding	IT infrastructure and interoperability
Tech transfer and drug-substance manufacturing	Vaccination-dispensing strategy	Logistics, transport, and warehousing	Healthcare work-force education	Reimbursement strategy	Ongoing monitoring and reporting
Upstream/down-stream sourcing and manufacturing					
Public-policy planning					

Strategic considerations associated with uncertainty

Capability and implementation planning

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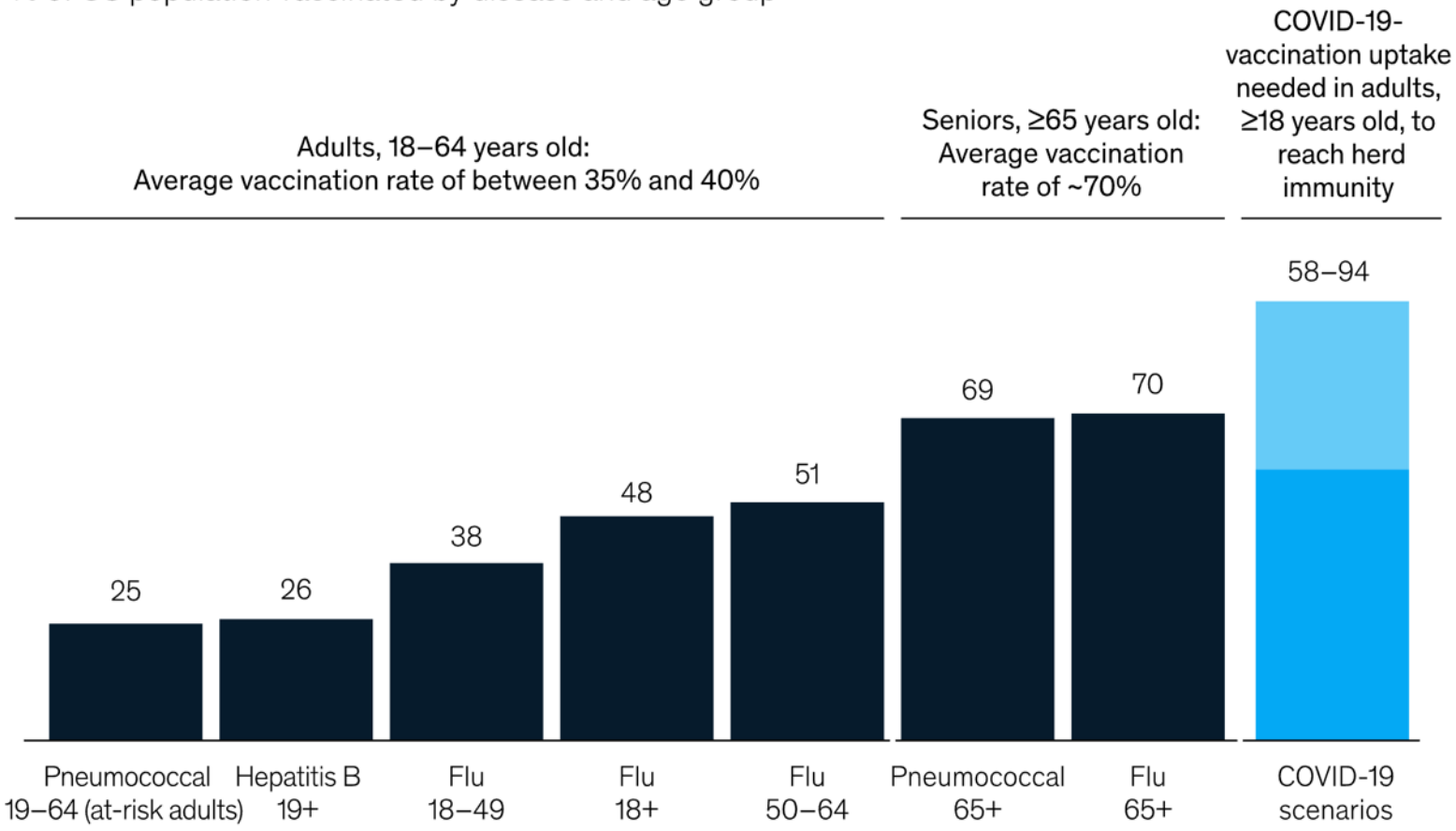
Source: McKinsey: When will the COVID-19 pandemic end? November 23, 2020

Vaccination uptake to achieve the end game:

Ending the pandemic could require COVID-19-vaccination uptake in the range of between 58 percent and 94 percent, higher than most adult-vaccine benchmarks.

Overall COVID-19-vaccine rates may be lower than flu or pneumococcal rates for seniors,
% of US population vaccinated by disease and age group



Source: Centers for Disease Control and Prevention

Source: McKinsey: When will the COVID-19 pandemic end? November 23, 2020

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Standardisation / Mutual Recognition / certification

Issues to address

- Equivalence: In a likely scenario with multiple vaccines with differing performance characteristics how to ensure they are treated equal for cross-border travel?
- Mutual recognition: Need to ensure that both the vaccine and the supporting certificate are genuine and avoid the fraud issues that affect Yellow Fever
- Certification: Paper based vs digital health certificate. Integration with airline and government systems. Meet privacy requirements.

Risk

- If States do not trust vaccination certificates, antibody testing on departure and/or arrival could become an additional requirement

Roles and responsibilities

- Need to clear delineate roles for ICAO, WHO and CAPSCA
- Responsibilities of airlines vs government border control at exit and entry

Need solutions that are simple for passengers to implement and that do not create a burden for airlines

https://sciencebusiness.net/covid-19/news/digital-immunity-passports-covid-19-experts-are-not-sold-idea

‘Cautious optimism’

Caution

1. Validating unproven technologies.

- Newer technologies (e.g. DNA and messenger RNA) accelerate development time but largely unproven (no licensed vaccines for humans).
- Logistics - Challenging ultra-cold chains for Pfizer

2. Efficacy/Safety - Demonstrating protection against COVID-19.

- Disease blocking vs transmission blocking (sterilising) vaccines
- % coverage to achieve herd immunity – efficacy and uptake
- Prevention of serious disease
- Will longer term safety issues emerge with higher numbers?
- Aircrew safety?

3. Targeting the appropriate vaccine design.

- Will SARS CoV-2 mutate around the spike protein - could affect the relevance of the current candidates, as most designed around the spike protein.
- A race against natural selection as strains with competitive advantages dominate

4. Government risk appetite

- What are the criteria that it is ‘safe to open up’?

Optimism

1. Virus characteristics
   - low to moderate mutation rate (4 x slower than Influenza)
   - MERS virus hasn’t mutated substantially since 2012 (but considerably less replications).
   - Some evidence mutations are affecting the transmissibility of COVID-19, but so far, minimal effect on antigenicity.
   - Sustained attack rate allows developers to assess vaccine efficacy rapidly in Phase III.

2. Pipeline and technology platforms
   - Unprecedented activity - first vaccine candidate was created 42 days after genetic sequencing.
   - More than 250 candidates globally and 5 approved vaccines
   - Broad range of technologies, from proven vaccine platforms (protein-subunit and viral vectors) to novel ones (mRNA and DNA).
   - 50% efficacy benchmark likely to be met by a large number of candidates

3. Access to funding
   - COVID-19 vaccines have received more funding than any prior vaccine
     - From 2003 to 2014, the US National Institute of Allergy and Infectious Diseases invested $221 M for an Ebola vaccine vs. $1.5 billion in the first six months of 2020 for COVID-19 vaccine.
     - global investment in COVID-19 vaccines to date has totalled at least $6.7 billion.

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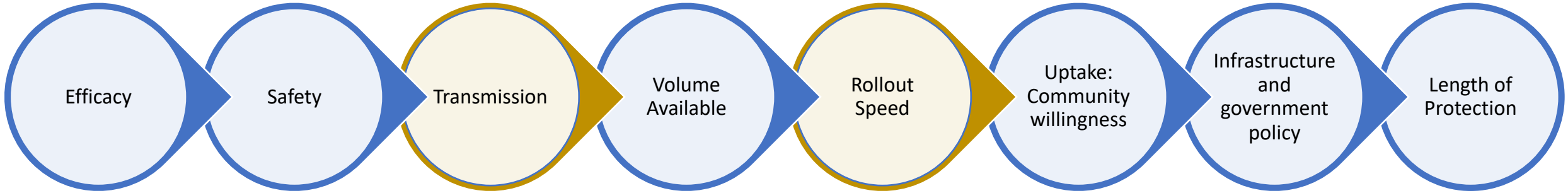
A scorecard for the ‘hurdle race’?



Efficacy	Safety	Transmission	Volume Available	Rollout Speed	Uptake: Community willingness	Infrastructure and government policy	Length of Protection
How will Efficacy Profile Influence Permission to Travel?	Safety profile may influence which group approved to take specific Vaccines	Community Risk may be Influenced by whether Vaccine limits transmission	Supply may be limited or insufficient	Rate of vaccine manufacture, distribution and administration	Sufficient comfort in community on need and safety profile	Verification requirements (Global and Local) for proof of travel	Requirement to re-vaccinate after a certain period
What % of infections are prevented? Do they protect vs. serious disease? Do they block asymptomatic infections? What % of population required to reach Herd Immunity levels?	Some vaccines profile untested on certain demographics Vaccine Profile will influence if vulnerable individuals provided Current candidates have data aged/vulnerable with protecting against severity Children may take longer	If vaccine doesn’t prevent or limit transmission, could delay comfort to open borders until sufficient population immunity reached Individual protection achieved, but risk to travel remains moderately high Initial indication of reduction of transmission, but no firm data.	Disproportionate distribution in different markets Most major aviation markets have good coverage on order Failure of any of the major contenders will have significant impacts	Prioritisation model (WHO) Limits on where manufactured Sovereign interests prioritised Orders outstrip supplies Inequities for developing nations	Varies across globe Transparency in safety profiles Trust in government Success in public health campaigns	Standardisation issues Mutual recognition If requiring digital proof of vaccination, facilitation system may not be until mid year Not confirmed what would be required to facilitate borders opening vs mass travel	Limited safety data around length of protection afforded. Increasing data supporting vaccination length growing sufficient for borders

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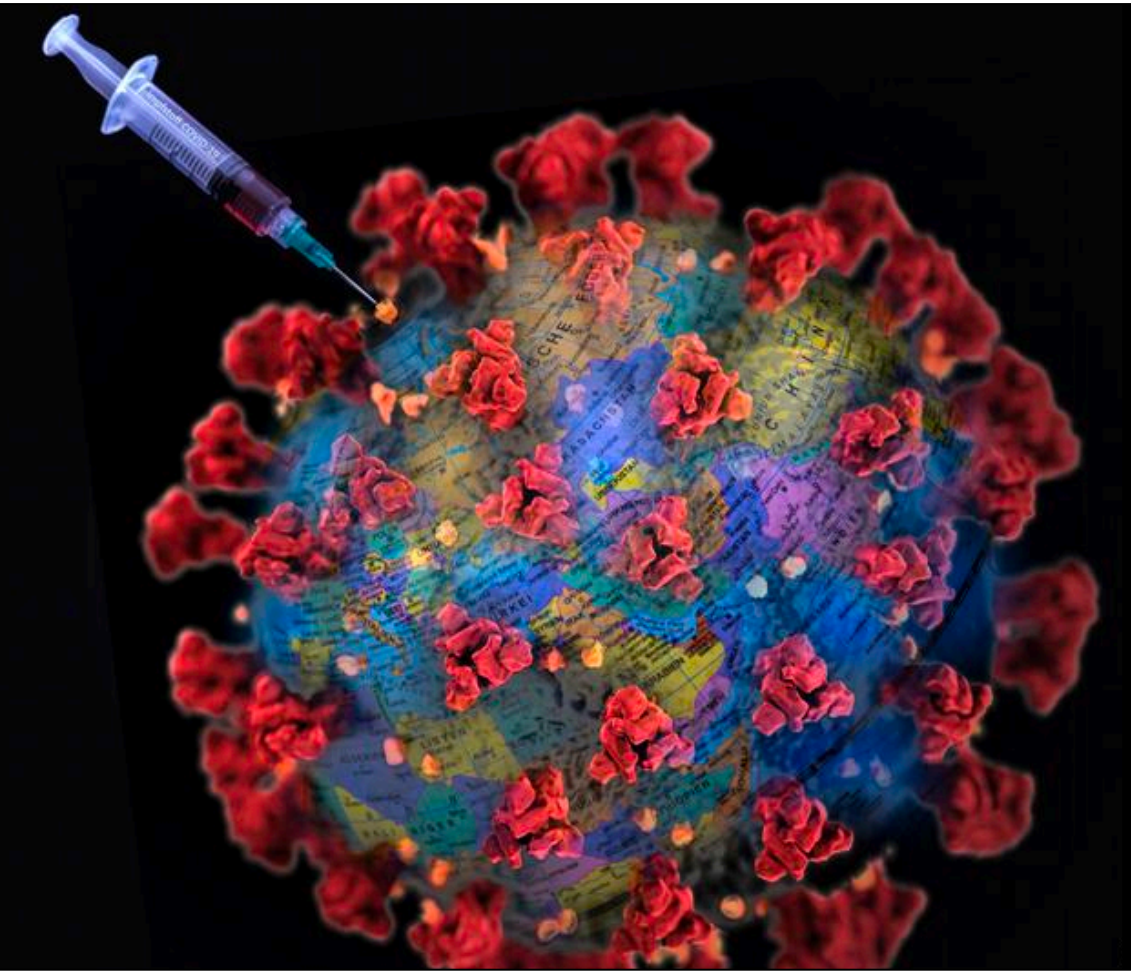
Required preparedness actions for airlines / governments



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Waiting for full vaccination before reopening borders is not an option

- Global vaccine roll-out is likely to take at least 12-24 months.
- Testing remains the bridge solution – critical for industry survival
- But, any traveller who has been vaccinated should not need to test or quarantine.

Governments should remove restrictions as soon as vulnerable groups vaccinated:

- Risks to population and healthcare system will have greatly reduced at this point
- Testing and quarantine requirements should no longer be applied
- Vaccination should not be a mandatory government requirement for international travel

Governments should prioritize aviation for access to vaccines

- Recognition of the role of aviation in vaccine distribution
- Aircrew and other aviation workers – once health workers and vulnerable groups vaccinated

Governments and industry need to work together on implementation:

- Standardized approach to ensure:
  - equivalent treatment of different vaccines and
  - mutual recognition and acceptance of vaccination certificates;
- Roadmap for managing the implementation period, including:
  - minimising complexity during the period where testing and vaccination overlap,
  - managing the removal of testing and other measures;

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Ian Hosegood

SARS CoV-2 Vaccines